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AN EXPERIMENTAL ANALYSIS OF PATTERNS OF DIFFERENTIAL VERBAL REINFORCEMENT IN CLASSROOM SITUATIONS

by

Edmund V. Mech
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J. Donavon Auble
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McCalla School, Bloomington

Mr. Herschell Fuller, principal; and Mrs. Respa Spaulding and Mrs. Bessie Moore, elementary teachers.

University School, Bloomington

Mr. Vere DeVault, elementary supervisor; and Mrs. Angela Beatty, elementary teacher.

Certainly, the present project has done much to engender a clearer understanding between administrator, teacher, and psychologist—a trend, we might add, that could profitably be perpetuated. Only when this type of co-operation is attained in large numbers of situations will it be possible to bring to a fruitful accomplishment a full program of psychological research on the group level.

E. V. M.
F. M. H.
J. D. A.
N. A. F.

AN EXPERIMENTAL ANALYSIS OF PATTERNS OF DIFFERENTIAL VERBAL REINFORCEMENT IN CLASSROOM SITUATIONS

Introduction

Mild controversies have raged for years with regard to the relative merits of praise and reproof as "incentives" toward improvement in a given task. The evidence is conflicting with regard to the relative effectiveness of either condition, although, generally speaking, it appears "accepted" in educational theory that praise is more effective, especially for younger children—more effective for what is not always clear. Simply to say that a human organism will learn faster when praised does not materially advance our understanding.

It is the opinion of the writers that a promising approach for current educational theory is one that employs a descriptive analysis of specific behavior under specified environmental condtions. This viewpoint, however, is not intended to by-pass the value of an eventual theoretical model, but rather to suggest an operational approach for handling classroom experimentation. A need for such a common framework among educational experimenters is clear. The area of classroom learning has been fraught with deviant results, largely by virtue of the fact that experimenters have tended to perform different operations upon differing organismic levels. As a result, a bewildering array of conflicting data have been collected, providing a stumbling block to the eventual construction of a model from which concrete predictions can be made.

Most textbooks have emphasized that educational psychologists should, in the main, concern themselves with experimentation in the area of human learning. Guthrie's opinion that undue emphasis has been placed elsewhere is evidenced by his statement, "The literature of mental tests had, over 20 years ago, collected some 10,000 test titles, and the number must be at least three times that figure by now." (6:5)* In effect, educational psychologists have devoted disproportionately more effort to testing persons than to basic learning experimentation.

In a recent review, Stroud indicates the need for a systematic behavior theory in education by stating, "Undoubtedly, one of the pressing needs in our field is a comprehensive learning theory (or behavior theory) that will encompass teaching and learning in school and embrace the broad phenomena of personality and adjustment. The educational psychologist is the logical person to attempt this. . . . A frank attempt to extend the current learning theory of Hull, Tolman, or others to learning in school is overdue." (17:282)

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*Numbers in parentheses refer to references in a numbered bibliography on page 24. Numbers which follow the colon refer to the specific page number on which the quotation is found.

Guthrie and Powers support this view with the following comment: "Research should increasingly deal with 'real' problems confronting educators. The use of human subjects in investigations will not lend itself to the rigid control of all variables that is often possible in a simple animal study; nevertheless, results of such 'imperfect' observations should serve the practical function of pointing the way to more certain success in teaching." (7:19)

Actually, animal experimentation and theory construction have made rapid progress during the last decade, presenting the educational psychologist with many concepts and hypotheses that might feasibly and properly be tested under classroom conditions. To mention one specific instance, the advantage in resistance to extinction of partial reinforcement over continuous reinforcement has received considerable attention from both experimenters and theorists since Skinner's 1938 book (16) and Humphrey's report (8) of the phenomenon in 1939. As Mowrer (12) points out, it was long assumed that the basic truth concerning learning was embodied in the law of exercise, which held that every performance of a habit necessarily strengthened that habit. But evidence gradually accumulated which suggested that "exercise," as such, has little to do with the strength of a habit. It was rather the presence or absence of reinforcement that seemed important. This proposition that every rewarded repetition of a habit strengthens it is, however, open to question.

Numerous "partial" reinforcement experiments certainly offer an obstacle to the acceptance of this viewpoint. For example, in an earlier work Pavlov (13) describes an experiment performed in his laboratory in which conditioned salivation in a dog was established with food reinforcement on every other trial and on every third trial. This means, simply, that Pavlov was successful in demonstrating the conditioned response both with 50 per cent and 30 per cent food reinforcement.

More recently, in a verbal conditioning study, Mech (11) found that by massing trials 50 per cent reinforcement is as efficient as 100 per cent reinforcement in producing acquisition to a criterion. His results indicated also that extinction is slower following the 50 per cent reinforcement than following the 100 per cent reinforcement.

Jenkins and Stanley in their review of the literature on partial reinforcement make this statement: "It is quite straightforward in view of the consistency of the data. All other things equal, resistance to extinction after partial reinforcement is greater than that after continuous reinforcement when behavior strength is measured in terms of single responses. A necessary condition for the operation of this principle appears to be massing of training trials or responses, at least with infrahuman subjects." (10:222)

However, the action of an important variable in the study of partial reinforcement has been demonstrated by Sheffield (14). She found that resistance to extinction is slightly (not significantly) better after continuous reinforcement when the training trials have been spaced. With

massed practice, the findings were reversed, and the typical difference favoring the partial group was obtained. In a recent classroom study by Auble and Mech (3), the results of the Sheffield experiment were confirmed insofar as no differences were found in extinction when trials were spaced.

The Problem

The data presented by Sheffield and by Auble and Mech appear to be relevant to a situation educators face in the classroom. Partial reinforcement is certainly more nearly like the everyday life situation than 100 per cent reinforcement. It is rare, indeed, that every response leads to the presentation of a reinforcing stimulus. Continuous reinforcement, then, seems to be the exception, not the rule.

It was previously pointed out that the superiority of partial reinforcement over continuous reinforcement with respect to greater resistance to extinction appears dependent upon whether the trials are massed or spaced. However, one is prone to question whether classroom "reinforcements" are meted out in a mass or in spaced fashion. It is probably safer to assume that, in general, classroom reinforcements are administered in somewhat of a spaced or distributed manner. It is most unlikely that schoolroom reinforcements are dealt out in a massed fashion.

The hypotheses to be tested in the present set of experiments were as follows:

(a) Acquisition would be as efficient with 50 per cent reinforcement as with 100 per cent reinforcement.

(b) After massed training, resistance to extinction would be significantly greater for 50 per cent reinforcement groups than for 100 per cent reinforcement groups.

(c) Partial reinforcement would have less advantage in "resistance to extinction" if classroom subjects were used with trials widely spaced than if they were used with massed trials.

Several practical outcomes appear to be embodied in the results of such experimentation, which at first glance appears somewhat removed from classroom application. For example, if reinforcement or praise is to be effective, should it be administered in a massed or a spaced fashion? Surprisingly enough, there are no direct classroom data at present that permit conclusions to be drawn. Educators, taking their cues from Thorndikian studies, generally accept the "law of effect." That is, pupils will learn faster when rewarded than when not rewarded. If, however, reward, reinforcement, or praise is more effective when given in massed "blocks," educational practice should benefit from this knowledge.

Another practicality implied in a hypothesis being tested is that pupils who are reinforced a certain percentage of the time will probably perform just as well as those who received reinforcement continuously over the interval of time. In other words, reinforcement does not necessarily have to be given every time in order to be effective.

A Methodological Comment

It is well known that experimental results can best be evaluated in the light of the measures which have been taken to insure operational isolation of the variables under consideration. However, psychologists have usually been unable to secure complete control of experimental conditions and have resorted to the use of large numbers of subjects in the hope that the effects of uncontrolled factors would average out. In classroom situations it is often difficult to obtain a large sampling of subjects. In order to investigate the phenomena under consideration, it was necessary to obtain a rather large number of responses from each subject over a relatively extended period of time. Also, prior to the accumulation of data, it was decided to reject the null hypotheses when the statistical tests were significant at the .05 level. A more stringent criterion of statistical significance would not be especially relevant to the program of classroom experimentation where the probability of experimental error was large.

General Procedure

The subjects were fourth grade pupils from Central School in Martinsville, a city of 5,000, and from McCalla School, Elm Heights School, and University School in Bloomington, a city of 30,000. Both cities are located in south central Indiana. The experimental design is indicated below. Each of groups A, B, C, and D was composed of two separate fourth grade classes, and each pair of classes was divided into three subgroups. In all, 240 pupils were involved as subjects, making 20 subjects in each subgroup. Each subject was given 20 trials—14 acquisition trials and 6 extinction trials.

DESIGN OF THE EXPERIMENT

Subgroup	Massed training		Spaced training	
	A. Massed extinction (MM)	B. Spaced extinction (MS)	C. Massed extinction (SM)	D. Spaced extinction (SS)
I	100%	100%	100%	100%
II	50%	50%	50%	50%
III	0%	0%	0%	0%

Trial 1 was devoted to obtaining an initial measure of ability in a routine computational task for all groups. The assignment of subjects to the three subgroups was done randomly, using tables of random sampling numbers prepared by the Rand Corporation (18).

Condition A consisted of massed reinforcement and massed extinction (referred to as MM)—extinction being operationally defined as the withholding of reinforcement by the teacher. During the acquisition phase, trials 1 through 14, one subgroup was given 100 per cent reinforcement, that is, reinforced on each of the first 14 trials. Another subgroup was given 50 per cent reinforcement, i.e., reinforcement on alternate trials. Thus, this group received seven reinforcements. The remaining subgroup received no reinforcement but was in the presence of the reinforcing stimuli administered to the other pupils. No reinforcement was given to any group during extinction trials 15 through 20.

Condition B consisted of massed acquisition trials but spaced extinction trials (referred to as MS). A 10-minute interval separated the spaced trials. The three subgroups received 100 per cent, 50 per cent, and 0 per cent reinforcements during acquisition. Condition B differed from Condition A only in the spacing of the extinction trials.

Condition C consisted of spaced acquisition trials and massed extinction trials (referred to as SM). Thus, 10 minutes existed between each of the 14 acquisition trials, but the six extinction trials were run in immediate succession.

Condition D consisted of spaced acquisition trials and spaced extinction trials (referred to as SS). Ten minutes existed between all trials both during acquisition and during extinction.

A trial consisted of a four-minute period during which subjects worked routine arithmetical problems. Sufficient problems were provided for each trial so that the most rapid subject was unable to complete the list within the time limit.

An attempt was made in the experimental procedure to maintain the semblance of the normal classroom climate. The regular teacher was used, and she avoided mentioning that an experiment was being carried out.

The verbal reinforcement was similar to that used by Auble and Mech (1; 2; 3; 4) in previous classroom investigations. Each teacher was required to adhere to the following procedure for reinforcement and extinction during the experiment: The teacher would walk around the classroom during each trial while the children were working on the task, and the teacher pretended that she was jotting down the names of those who were doing "good" work. Following each acquisition trial the teacher would state:

"The following children did very nice work on the last set of problems and are improving faster than the rest of the class." (The teacher would read the names of children to receive reinforcement.) "Now I want to see how much better you children can do on the next set of problems. Try to avoid any careless mistakes, and try to do as many problems as you can."

Actually, the names of the children receiving reinforcement were predetermined by random sampling. During the six extinction trials, the teacher continued walking around the classroom but no reinforcements were given.

The assumption, of course, is that the verbal stimuli from the teacher, designated as belonging to a class "reinforcing," are stimuli that will increase the probability that a particular class of response will occur more frequently than it would if these stimuli were withheld.

Results and Discussion

For the purpose of maintaining continuity, the results of the analysis of correct responses and error responses will be presented separately.

Figure 1 shows the accumulated correct responses for the 100 per cent, 50 per cent, and 0 per cent reinforcement groups during the 14 massed acquisition trials.

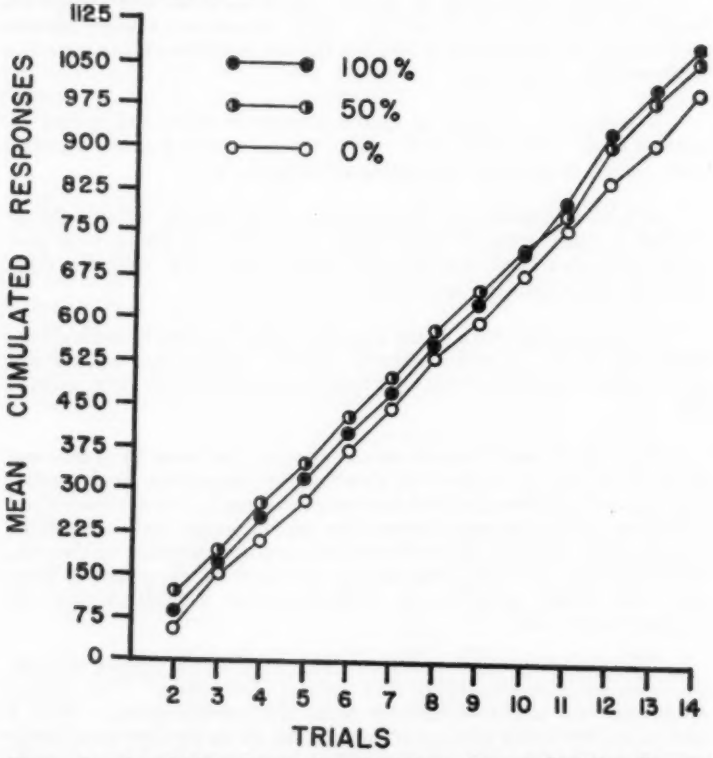

Figure 1. Acquisition Curves for the Three Massed Training Groups, Showing Mean Cumulated Correct Responses

Figure 2 exhibits the cumulated correct responses for the three reinforcement groups during the 14 spaced acquisition trials.

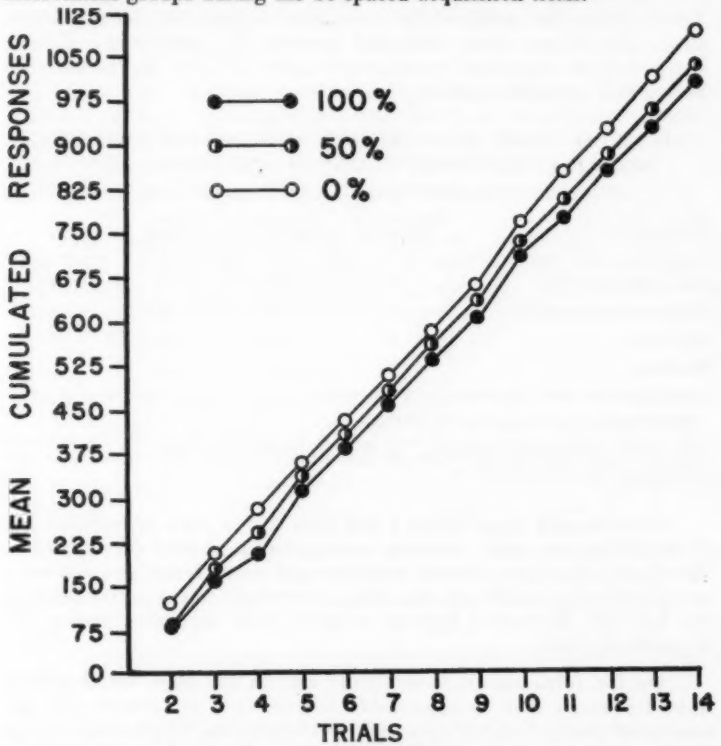

Figure 2. Acquisition Curves for the Three Spaced Training Groups, Showing Mean Cumulated Correct Responses

In order to test for possible differences among inter-trial intervals (massed vs. spaced training) and differences among reinforcement schedules (100 per cent, 50 per cent, 0 per cent), it was decided to use an analysis of covariance. However, the data presented in Figures 1 and 2 in their present form were not amenable to a straightforward statistical analysis, because the successive means and variances were proportional and the distributions somewhat skewed. This occurs quite frequently when working with correct and error responses, and is to be expected. Therefore the use of an analysis of covariance at this point is not justifiable because of the possibility of violating several basic assumptions.

Bartlett (5) recommends a square root transformation when the distribution is such that the means and variances tend to be proportional to one another within the various experimental conditions. It was decided to apply the appropriate square root transformation ($\sqrt{x}$) to all

the data in the experiment, so as to meet more adequately the assumptions underlying the model before applying covariance analysis. Table 1 summarizes the results of the covariance analyses for the acquisition phase. Covariances were computed between the transformed Trial 1 scores and the cumulated transformed scores of Trial 14, the last trial during the acquisition phase.

TABLE 1. SUMMARY OF COVARIANCE ANALYSES FOR DIFFERENCES IN CORRECT RESPONSES DURING 14 ACQUISITION TRIALS†

Source of variation	Degrees of freedom	Sum of squares	Mean square	F
Inter-trial interval	3	105.08	35.03	3.84*
Reinforcement pattern	2	2.58	1.29	.14
Interaction	6	29.57	4.93	.54
Residual	227	2,072.01	9.13	

*Significant at the .05 level of confidence.

†A square root transformation was applied to the raw data. The covariance analyses were carried out between the Trial 1 scores and the transformed cumulated scores on Trial 14.

As evidenced from Tables 1 and 2 for 227 degrees of freedom, the F of 3.84 for inter-trial intervals was significant at the 5 per cent level. The F ratios for reinforcement schedules and interactions, however, were not statistically significant. The most interesting finding at this point is the lack of differences between reinforcement schedules during the acquisition phase.

On the infra-human level (white rat) it has been demonstrated quite frequently that no appreciable differences exist between 100 per cent reinforcement and 50 per cent reinforcement. Simply, this means that organisms reinforced only half the time perform as well as those reinforced all the time. One would be hard pressed to deduce this finding validly from Thorndike's classical law of effect.

A point of major interest, however, is that the pupils receiving no direct reinforcements from the teacher (0 per cent) but who were in the presence of the reinforcing stimuli performed just as well as the other two groups. This phenomenon of the generalization of the reinforcing stimuli has also been demonstrated elsewhere (1; 2; 3).

Certainly, this finding should imply to the classroom teacher that, although some pupils may not be directly reinforced, if they are in the presence of such reinforcement the effects are mediated.

A case in point is Hurlock's (9) classic experiment on praise and reproof in which she demonstrated that praise was superior to ignoring pupils. Recent experimental evidence certainly does not support this generalization. Pupils in the presence of praise or reinforcement are not being ignored.

The results, then, are in accord with most infra-human studies that show no difference between continuous reinforcement (100 per cent) and partial reinforcement (50 per cent) during the acquisition of a selected behavior.

A second important result seen from Table 1 is the statistical difference during acquisition that is attributable to the inter-trial interval. In order to test whether the differences were between the two massed and two spaced groups or whether they were within the massed or the spaced groups alone, an analysis of covariance was carried out.

The analysis is summarized in Table 2, and indicates that at the .01 level of confidence the differences were between the two spaced groups when compared with the two massed groups. The group receiving massed training performed significantly better than the group receiving spaced training.

TABLE 2. SUMMARY OF COVARIANCE ANALYSES FOR DIFFERENCES IN CORRECT RESPONSES DURING ACQUISITION BETWEEN THE TWO SPACED AND TWO MASSED GROUPS

Source of variation	Degrees of freedom	Sum of squares	Mean square	F
Inter-trial interval	1	104.72	104.72 ~~11.73~~	11.73**
Residual	233	2,081.17	8.93	
Sum	234	2,185.89		

**Significant at the .01 level of confidence.

In regard to the results during the "extinction" phase, operationally defined as Trials 15 through 20, during which no reinforcement was given to any group, Figures 3 and 4 show the extinction curves for the various reinforcement conditions after massed and spaced training, respectively.

Analyses of covariance were carried out between the transformed cumulated responses at the end of Trial 14 (last acquisition trial) and the transformed cumulated responses on the last extinction trial (Trial 20).

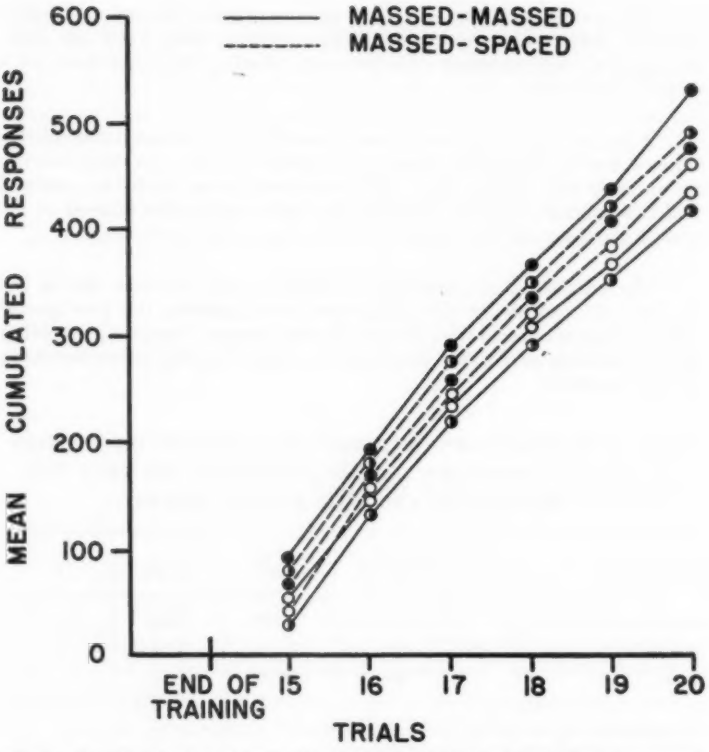

Figure 3. Extinction Curves for 100%, 50%, and 0% Reinforcement Groups After Massed Training, Showing Cumulated Number of Correct Responses

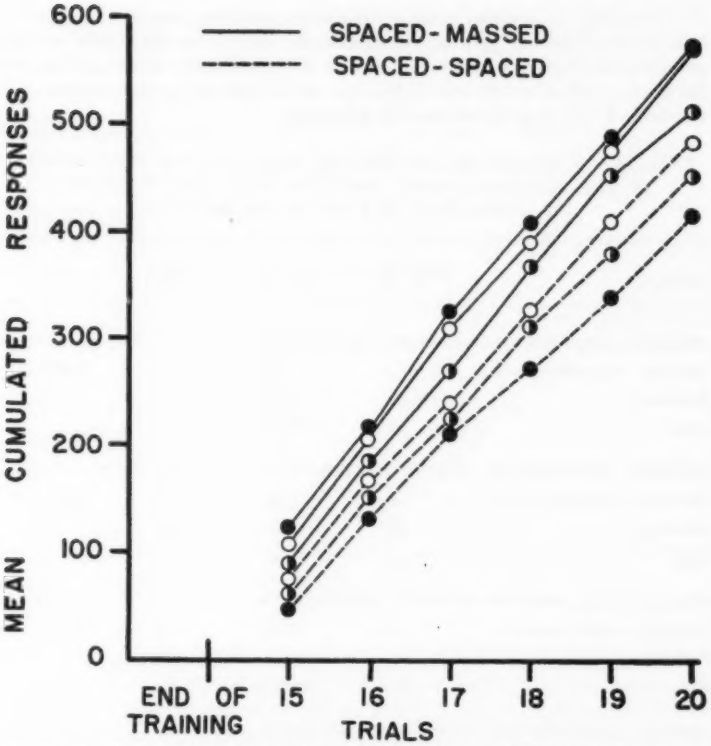

Figure 4. Extinction Curves for 100%, 50%, and 0% Reinforcement Groups After Spaced Training, Showing Cumulated Number of Correct Responses

As evidenced in Table 3, differences were found to exist in extinction for the inter-trial interval and reinforcement schedules.

TABLE 3. SUMMARY OF COVARIANCE ANALYSES FOR DIFFERENCES IN CORRECT RESPONSES DURING SIX EXTINCTION TRIALS†

Source of variation	Degrees of freedom	Sum of squares	Mean square	F
Inter-trial interval	3	32.36	10.79	2.89*
Reinforcement pattern	2	34.82	17.41	4.66*
Interaction	6	22.36	3.73	
Residual	227	848.81	3.74	

*Significant at the .05 level of confidence.

†Covariance analyses were carried out between the Trial 14 total transformed cumulated responses and the transformed cumulated responses on Trial 20.

In order to determine which training condition, massed or spaced, was responsible for producing significant change in extinction among reinforcement groups, covariance tests of significance were carried out between reinforcement schedules for each training group during extinction. Table 4 summarizes this analysis.

TABLE 4. SUMMARY OF COVARIANCE ANALYSES FOR DIFFERENCES IN THE REINFORCEMENT PATTERN FOR EACH TRAINING CONDITION DURING EXTINCTION

Groups	Degrees of freedom	Sum of squares	Mean square	F
MASSED ACQUISITION—MASSED EXTINCTION				
Between reinforcements	2	22.10	11.05	6.91**
Residual	56	89.39	1.60	
Sum	58	111.49		
MASSED ACQUISITION—SPACED EXTINCTION				
Between reinforcements	2	7.49	3.75	2.84
Residual	56	74.10	1.32	
Sum	58	81.59		
SPACED ACQUISITION—MASSED EXTINCTION				
Between reinforcements	2	12.20	6.10	1.31
Residual	56	259.97	4.64	
Sum	58	272.17		
SPACED ACQUISITION—SPACED EXTINCTION				
Between reinforcements	2	15.10	7.55	1.01
Residual	56	420.76	7.51	
Sum	58	435.86		

**Significant at the .01 level of confidence.

As indicated in Table 4, the only training group contributing to the significant differences among reinforcement patterns was the MM group, which received both massed training and massed extinction. The group receiving massed training and spaced extinction, as well as the spaced training groups, failed to produce any significant differences. These findings appear to correspond quite well with a hypothesis that resistance to extinction is greater after massed training than after spaced training.

Next, a question was raised with regard to whether reinforcement patterns within the MM group were different from each other. Table 5 summarizes the covariance analyses carried out to test for the source of differences in extinction among these groups.

TABLE 5. SUMMARY OF COVARIANCE ANALYSES FOR EXTINCTION DIFFERENCES BETWEEN THE THREE REINFORCEMENT GROUPS RECEIVING MASSED TRAINING AND MASSED EXTINCTION

Reinforcement groups	Degrees of freedom	Sum of squares	Mean square	F
100% VS. 50%				
Between reinforcements	1	11.23	11.23	5.61*
Residual	37	73.93	2.00	
Sum	38	85.16		
100% VS. 0%				
Between reinforcements	1	.26	.26	.14
Residual	37	68.82	1.86	
Sum	38	69.08		
50% VS. 0%				
Between reinforcements	1	20.17	20.17	21.46**
Residual	37	34.66	.94	
Sum	38	54.83		

*Significant at the .05 level of confidence.
**Significant at the .01 level of confidence.

A curious result is evident in the analysis presented in Table 5. Differences were found between the 100 per cent and 50 per cent groups in favor of the 100 per cent group. The differences between the 100 per cent and 0 per cent groups were not significant. The differences between the 0 per cent and the 50 per cent groups, however, were significant in favor of the 0 per cent reinforcement group.

This may be summarized as follows: No differences existed between the 100 per cent and 0 per cent groups, but both were statistically different from the 50 per cent group. This latter finding is not compatible with the often verified finding that there is greater resistance to extinction after 50 per cent reinforcement than after 100 per cent reinforcement under massed training conditions. It would be rather unexpected, in such an exploratory study, to obtain results similar at every turn to data obtained on the infra-human level. Two major points stand out so far: (a) Pupils given massed reinforcement tend to give significantly more responses in extinction when reinforcement is withheld than do pupils who are given reinforcement in spaced intervals. This result corresponds fairly well with infra-human data. (b) Another finding compatible with infra-human data is that partial reinforcement is as effective as continuous (100 per cent) reinforcement for producing performance changes in the acquisition or training stage. Certainly this theory has much animal data to support it. (c) The 0 per cent reinforcement pupils (pupils who did not directly receive reinforcement

but were in the presence of the reinforcing stimuli) performed as well as the two groups receiving direct reinforcement. This evidence strongly suggests that reinforcing or praising various pupils in a classroom tends positively to mediate the reinforcing stimulus to the other pupils.

Figures 5 and 6 present the mean cumulated errors during the 14 trials in the acquisition phase for the massed and spaced training groups. A statistical analysis similar to that for correct responses was carried out for error responses. The covariance analyses were computed on the error date after a $\sqrt{x + 0.5}$ transformation had been made. Table 6 summarizes the analysis carried out on the tranformed scores between the initial trial and the cumulated totals of the last acquisition trial (Trial 14). None of the F ratios in Table 6 proved to be statistically significant, that is, no differences existed among the three reinforcement patterns or between the massed or spaced trials.

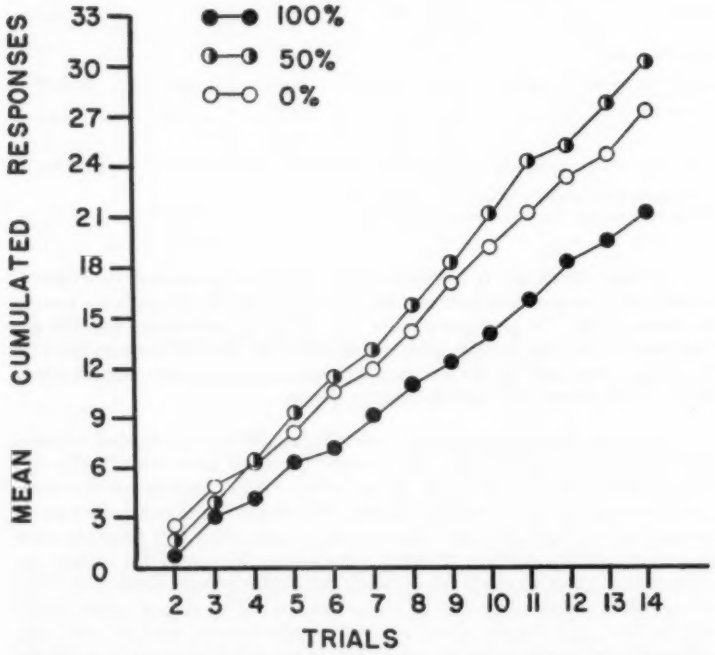

Figure 5. Acquisition Curves for the Three Massed Training Groups, Showing Mean Cumulated Error Responses

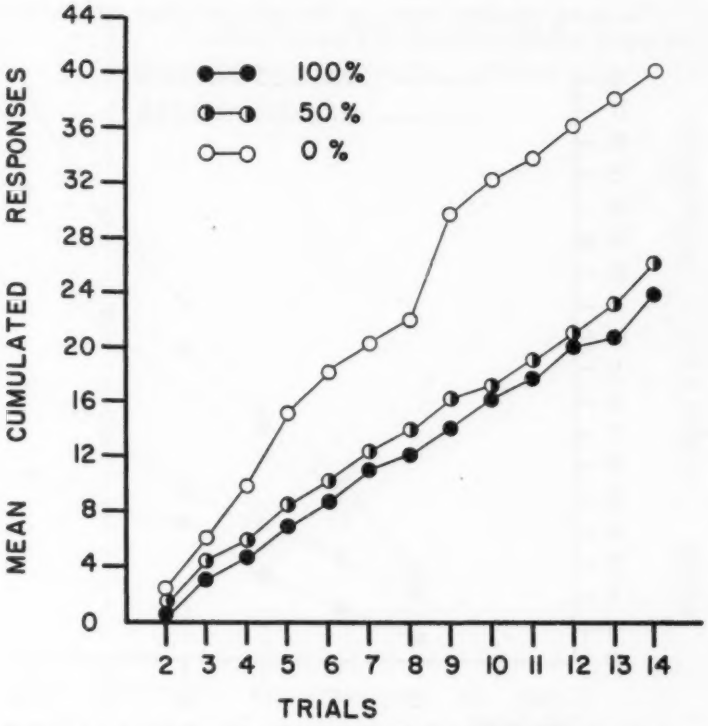

Figure 6. Acquisition Curves for the Three Spaced Training Groups, Showing Mean Cumulated Error Responses

TABLE 6. SUMMARY OF COVARIANCE ANALYSES FOR DIFFERENCES IN ERROR RESPONSES DURING 14 ACQUISITION TRIALS†

Source of variation	Degrees of freedom	Sum of squares	Mean square	F
Inter-trial interval	3	9.00	3.00	.61
Reinforcement pattern	2	.33	.17	.03
Interaction	6	21.91	3.65	.74
Residual	227	1,115.77	4.92	

†A $\sqrt{x + 0.5}$ transformation was applied to the original data. The covariances were computed between the responses on Trial 1 and the cumulated responses on Trial 14.

The mean cumulated errors for the extinction phase after massed and spaced training are shown in Figures 7 and 8.

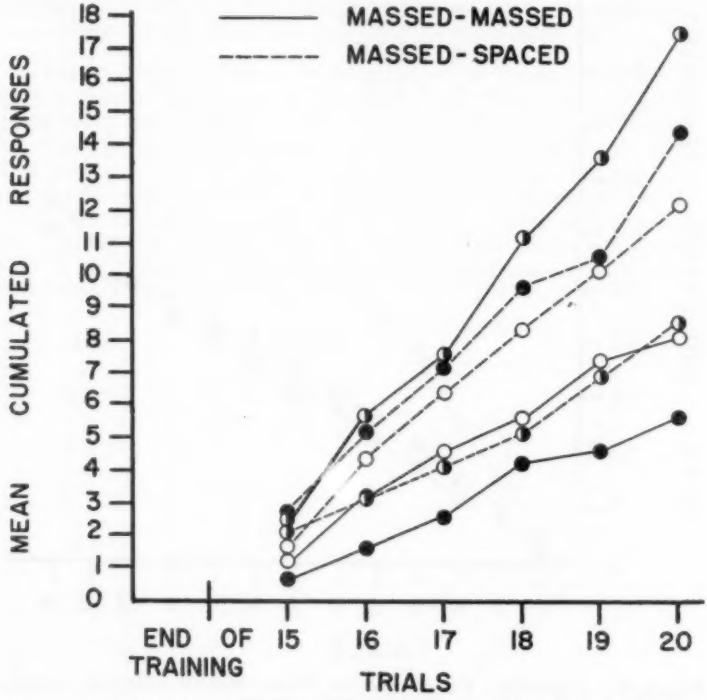

Figure 7. Extinction Curves for 100%, 50%, and 0% Reinforcement Groups After Massed Training, Showing Cumulated Number of Error Responses

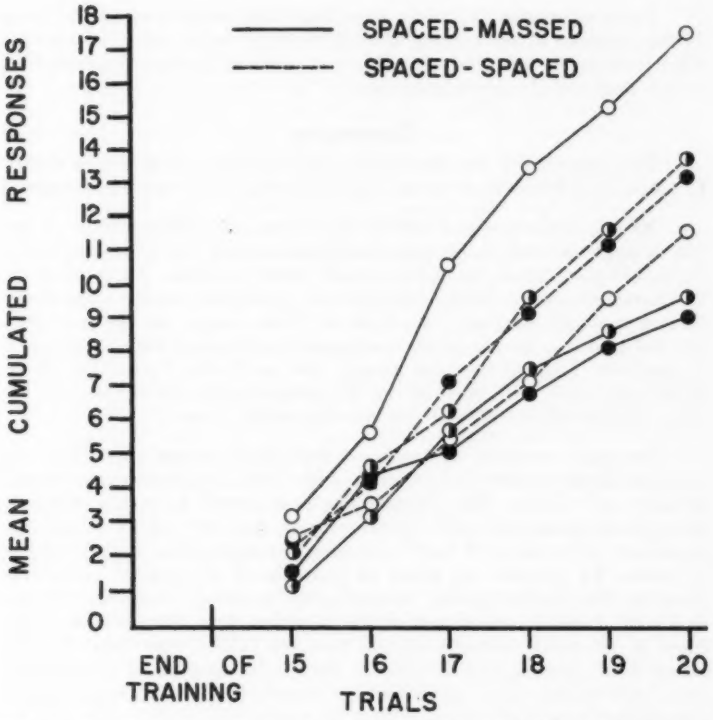

Figure 8. Extinction Curves for 100%, 50%, and 0% Reinforcement Groups After Spaced Training, Showing Cumulated Number of Error Responses

Table 7 summarizes the covariance analysis carried out for the extinction phase—computed between Trial 14 (the last acquisition trial) and Trial 20 (the final extinction trial). It is not surprising that no error differences were found between reinforcement groups.

TABLE 7. SUMMARY OF COVARIANCE ANALYSES FOR DIFFERENCES IN ERROR RESPONSES DURING SIX EXTINCTION TRIALS†

Source of variation	Degrees of freedom	Sum of squares	Mean square	F
Inter-trial interval	3	.55	.18	.12
Reinforcement pattern	2	.22	.11	.07
Interaction	6	14.71	2.45	1.62
Residual	227	343.87	1.51	

†A $\sqrt{X + 0.5}$ transformation was applied to the original error data.

Previous studies (1; 2; 3) show that direct reinforcement, or being in the presence of reinforcing stimuli, tends to reduce error variability. Clearly, then, the relatively significant aspects of the data are embodied in the analysis of correct responses.

Summary

This experiment was designed to test various hypotheses in regard to patterns of differential verbal reinforcement in a classroom situation.

All the subjects were fourth-graders from the public schools of one city of approximately 5,000 population and another city of approximately 30,000 population, located in south central Indiana. These subjects, 240 in number, were divided into two large groups to receive massed and spaced training, respectively. Each of these larger groups was subdivided into two groups to receive massed and spaced extinction trials, respectively. Each of the four groups was randomly divided into three more subgroups, with each of the 12 groups having 20 subjects, to receive respectively 0, 50, and 100 per cent reinforcement.

The task consisted of routine arithmetical computation. The acquisition phase consisted of 14 trials, with Trial 1 representing an initial measure of ability. The extinction phase lasted from the fifteenth through the twentieth trial. Reinforcement was defined as verbal approbation or praise, and lasted variously throughout the first 14 of the 20 trials. To preserve as much as possible of the typical classroom situation, the treatments were administered by actual classroom teachers under the careful supervision of the experimenters. Acquisition is defined as the total correct response between Trial 1 and Trial 14. To satisfy basic assumptions involvd in the use of analysis of covariance, cumulated scores were modified by means of a square-root transformation.

The following conclusions were drawn:

1. There were no significant differences in level of performance on the acquisition trials under conditions of 100 per cent, 50 per cent, and 0 per cent reinforcement. One should bear in mind, however, that the nonreinforced subjects were in the presence of those receiving reinforcement.

2. There were significant differences in performance levels between groups receiving massed training and those receiving spaced training during the acquisition trials. The differences were to the advantage of those receiving massed training.

3. After massed training, resistance to extinction was significantly greater for groups receiving 100 per cent reinforcement than for groups receiving 50 per cent reinforcement.

4. After spaced training, the differences in resistance to extinction for differentially reinforced groups were not significant.

5. Massed trials with 100 per cent verbal reinforcement appeared to increase the probability of obtaining a higher frequency of satisfactory responses.

Discussion

It is evident that the limitations inherent in the nature of the learning materials, the extent and representativeness of the population sample, and the amount of time allowed in carrying out the procedures in this experiment preclude any broad generalizations from the findings. Psychological texts contain too many such generalizations, drawn from group experiments having many of the same or similar limitations. On the other hand, it is conceivable that experiments like this, involving human subjects in a partially typical environment, should contribute more to actual human learning theory than do experiments performed on infra-human subjects. Most learning theorists would probably admit that a substantial amount of present theory has subsumed some type of anthropomorphic relationship between the responses of humans and those of lower animals under similar conditions.

Before making any suggestions for the teacher who is experimentally minded, we would like to enter a note of caution to the effect that these findings should be considered essentially exploratory in nature. The main function of such experimentation as this is to suggest a possible avenue for an intensive program of future research on a group basis, involving the area of learning and reinforcement theory. With the above recommended attitude of caution, we offer the following suggestions for the classroom teacher:

1. Teachers might consider using a trial method in which verbal reinforcement is offered in a massed fashion. For effective results, at least in simple tasks, these findings suggest that pupils not only be given verbal approbation but that such approbation be massed rather than spaced in the traditional manner. There seems to be no reason to disbelieve that massed reinforcement would be effective in more complex learning situations. The teacher might well test this theory by the empirical method.

2. Teachers should look for positive mediation effects in members of the class who do not receive such reinforcement. At least, the findings in this experiment indicate that such effects do exist. It was not within the compass of this analysis to determine differentiation of this generalized effect in terms of ability levels of the pupils. A teacher might easily determine, for example, whether more praise for low ability pupils alone might result in more acceptable achievement for those particular pupils as well as for those of higher ability.

3. The results seem to show that, for satisfactory acquisition, reinforcement need not always be carried out on a 100 per cent basis. Teachers might contribute much to the establishment of a distribution point in the percentage of reinforcement range above and below which the results seem to yield diminishing returns in relation to the difficulty of carrying out the procedure.

Finally, it is hoped that this report will stimulate more controlled experimentation of a similar nature, to the extent that it will be possible to widen the circle of knowledge about how learning takes place, and will thus provide a better basis for generalization.

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Bulletins in the Field of Education
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